



**To:** Karl Winterstein

**From:** Stephen Rolle  
Rob Fellows

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**Subject:** DRAFT - Applicability to the Alaskan Way Viaduct Study of Lessons learned in the closures of San Francisco's Embarcadero and Central Freeways.

## Issue

On October 17, 1989, the Loma Prieta earthquake disabled several highway facilities in the San Francisco area, including the elevated Embarcadero Freeway along the downtown waterfront, and the Central Freeway, another elevated freeway that distributed traffic to and from I-80 to the neighborhoods west of the CBD. Neither facility has been replaced in its original form. Instead, the Embarcadero was torn down and replaced by a series of shorter ramps to the downtown grid, while the Central Freeway is currently being replaced by a shorter freeway segment coupled with a new arterial improvement.

One option under investigation for the Alaskan Way Viaduct (AWV) is the replacement of the viaduct segment along the Seattle downtown waterfront with a surface arterial. Given the outward similarities between the AWV and these facilities, an investigation into what could be learned from the experiences in San Francisco was undertaken. This memo summarizes a review of information concerning the impacts of removing these freeways, and assesses the similarities and differences between these facilities and the Alaskan Way Viaduct (AWV).

## Summary Findings

The Embarcadero and Central Freeways in San Francisco had much in common with Seattle's Alaskan Way Viaduct in terms of appearance and the impact of the physical structures on their surroundings. Both of San Francisco's elevated freeways created unappealing, unsightly barriers whose physical presence tended to adversely affect the adjacent neighborhoods. As a result, both facilities proved extremely unpopular, and their development had a major hand in San Francisco's freeway revolt of the 1950's and 60's.

In terms of function and use, there are some important differences between the AWV and the two San Francisco freeways. Most obvious is that the Central Freeway's and Embarcadero's sole purpose (to the extent that they were developed) was to distribute traffic from the regional freeway system to the arterial grid of central San Francisco. The AWV, in addition to carrying 70,000 trips into downtown Seattle, also carries 40,000+ longer distance through trips daily.

Another important difference is that the function of the Central Freeway and Embarcadero in San Francisco was replaced by shorter ramp connections to a very dense, redundant street system. Downtown Seattle's street grid, which is constrained east-west by I-5 and the waterfront, does not offer the same opportunities to diffuse and redistribute trips. Furthermore, Seattle's grid is not well suited to carry trips into and out of downtown, as physical barriers to the north and south (Stadiums, Lake Union, topography) limit transportation corridors into the CBD to SR-99, I-5 and only a few arterial roadways.

Despite the differences noted, important lessons that could be pertinent to the development, selection, and construction of a replacement for the AWV can be learned from the freeway removal experiences in San Francisco. These include:

- Closure of the Central Freeway and Embarcadero did not reduce traffic levels; but instead displaced traffic to other nearby facilities (Trips did not disappear);
- Evidence indicates that there was not a noteworthy shift to transit or carpool modes after removal of the Central Freeway and Embarcadero, nor was there a reduction in trip making;
- Closure of the Central Freeway and Embarcadero increased volumes on other facilities, in many cases by 50% or more. While not clearly related to removal of the Embarcadero, many of these facilities are now congested to LOS F;
- Citizens in San Francisco appeared to be more tolerant of traffic congestion resulting from the closure of the Central Freeway for the short term than they were for the long term;
- A dense, redundant arterial grid, multiple distribution points (ramps) to the grid, and a series of high capacity one-way couplets helped accommodate traffic displaced by removal of the Central Freeway and Embarcadero;
- A multifaceted approach to traffic mitigation involving engineering, public awareness, and traffic enforcement was successful in helping accommodate traffic conditions in the short term after the removal of the Central Freeway;
- Traffic on the Embarcadero corridor decreased significantly primarily because removal of the freeway facility disconnected the corridor from the regional highway system, leaving a local street at the periphery of the street system.

## Background

### *Embarcadero Freeway*

The Embarcadero Freeway (California's State Route 480) was a short freeway segment that was intended as part of a longer facility that never completed. It was originally conceived as an Interstate 480 "Golden Gate Freeway" linking the Bay Bridge to the Golden Gate bridge at the north end of San Francisco, but only the first segment was constructed.

The double-decked Embarcadero structure was strikingly similar to the AWW visually, and it likewise separated San Francisco from its waterfront. **Figure 1** shows views of the former Embarcadero Freeway, which ran along the east shore of San Francisco above the Ferry Building and local streets serving waterfront activity. **Figure 2** shows the alignment on configuration of the Embarcadero prior to its removal.

Following the Loma Prieta earthquake, the Embarcadero freeway was torn down. The Embarcadero alignment was redeveloped as a surface roadway, with specific emphasis on multimodal, nonmotorized, and urban design elements. In the current configuration, ramps now connect to the arterial grid well west of the Embarcadero at Fremont St, and as a result, the Embarcadero corridor no longer is relied on to carry and distribute traffic to I-80.

### Traffic Distribution Before and After the Loma Prieta Earthquake



Source: A21 Design, "Vanished Embarcadero"

**Figure 1**  
**The Embarcadero Freeway**

Prior to the earthquake, the Embarcadero Freeway carried approximately 70,000 vehicles daily in the vicinity of the Ferry Building. Another 40,000 vehicles/day used associated ramps at Main and Beale Sts. In all, loss of the Embarcadero Freeway disrupted access to I-80 for a total of approximately 110,000 daily vehicles.

However, before and after traffic counts show that volumes increased on city streets by approximately 112,000 daily. **Table 1** shows traffic counts taken before and after the earthquake on north-south streets paralleling the Embarcadero Freeway alignment. The increase was greatest on Fremont and 1<sup>st</sup> Sts., since these are the primary access streets to and from I-80. These 1992 counts were taken before I-280 was fully reopened, and volumes on 6<sup>th</sup> street, which accesses I-280, increased to 29,197 in 1996 compared to 24,786 in 1992.

These counts show that traffic on the Embarcadero did not disappear once the freeway was closed, but instead was redirected to city streets that had adequate capacity to absorb the increase. Only a portion of the original traffic remained on the surface roadway following the freeway's original alignment, since other routes provide a more direct trip to and from the Bay Freeway.

#### Post-Closure Traffic Operations

Analysis of traffic conditions before and after the closure of the Embarcadero did not show a notable degradation in traffic conditions in the downtown area. The Embarcadero Replacement Project EIS/EIR (Parsons Brinckerhoff, et al, 1993) evaluated both pre- and post-earthquake conditions, and found only modest changes in traffic operating conditions level-of service (LOS), speed, stops/vehicle) on an area-wide level. Analysis of build options for 2015 likewise did not predict widespread failing LOS or excessive delays. Generally, operating conditions were forecast at LOS D or better, with only a few instances of poor level-of-service predicted (LOS E or F). These results indicate that the grid and remaining I-80 ramp system in downtown San Francisco had sufficient capacity to accommodate diverted trips.

Current intersection LOS data is not readily available. However, the San Francisco County Transportation Authority publishes a congestion map, which seems to indicate that current traffic conditions may be more congested than was predicted during evaluation of the replacement Embarcadero. During the PM Peak Period, Embarcadero St, Fremont St, 1<sup>st</sup> St, 5<sup>th</sup> St and 6<sup>th</sup> St all operate at LOS F in the downtown area (San Francisco County Transportation Authority, 2001). In the Embarcadero EIS/EIT, intersections on these streets were generally predicted to operate at LOS D or better for the same period in both the baseyear (1992) and forecast year (2015), with only a few cases of LOS E/F predicted. The poorer operating conditions reported today could be influenced by a number of factors unrelated to removal of the Embarcadero, but nonetheless indicate that the analysis presented during evaluation of Embarcadero replacement options did not overstate expected congestion levels.



Source: California State Automobile Association, circa 1984.

Figure 2 - Vicinity Map of the Former SR 480 Embarcadero Freeway and Beale/Main Ramps

**Table 1 –Traffic Volumes in Central San Francisco  
(Pre and Post Closure of the Embarcadero Freeway)**

Location	Embarcadero Open (pre-1989)		Embarcadero Closed (1992)		Percent Increase
	NB	SB	NB	SB	
Surface Embarcadero s/o Market	14,400	13,800	23,918	19,877	55%
Beale St. s/o Folsom		2,950		5,500	86%
Main St. s/o Howard	7,700		12,227		59%
Fremont St. s/o Howard	12,700		35,416		179%
1 <sup>st</sup> St. s/o Market		13,200		26,938	104%
2 <sup>nd</sup> St. s/o Howard	6,200	4,100	7,232	8,792	56%
New Montgomery s/o Market		11,000		13,000	18%
3 <sup>rd</sup> St. s/o Howard	25,800		28,845		12%
4 <sup>th</sup> St. s/o Market		14,000		25,000	79%
5 <sup>th</sup> St. s/o Howard	8,300	6,300	13,002	8,930	50%
6 <sup>th</sup> St. s/o Howard	9,000	15,000	9,293	15,493	3%
7 <sup>th</sup> St s/o Howard	11,000		17,517		59%
8 <sup>th</sup> St. s/o Howard		14,700		21,359	45%
9 <sup>th</sup> St. s/o Howard	26,100		30,949		19%
10 <sup>th</sup> St. s/o Howard		18,200		23,201	27%
TOTAL	121,200	113,250	178,399	168,090	
Both directions: 234,450		Both directions: 346,489		48%	
Total increase in Traffic Volume on City Streets: 112,039					

Source: San Francisco Department of Parking and Traffic



### *Central Freeway*

Like the Embarcadero, the Central freeway (US 101) was an elevated structure connecting I-80 to San Francisco's arterial grid. The Central Freeway was originally intended as a longer through route connecting to the Golden Gate Bridge, but again only the first segment was built. In its partially completed state, the Central Freeway served to connect the neighborhoods west of the CBD with I-80. **Figure 2** shows the original alignment and configuration of the Central Freeway.

In the years following the Loma Prieta earthquake, much debate and several changes in planned action took place. Originally, officials decided to remove the upper deck of the Central Freeway, but repair and retain the lower deck. During removal and reconstruction of the freeway, a multifaceted traffic mitigation campaign was undertaken to offset the closure of the facility. The campaign – which involved identification of several detour routes, traffic improvements to the detour routes, intensive public information, and increased traffic enforcement - was so successful in minimizing traffic impacts during the reconstruction that many residents and officials alike began to question the need for a Central Freeway link at all. In November of 1996, the Mayor of San Francisco requested that Caltrans not reopen the Central Freeway (Robbins, et al).

The decision to reverse course and keep the Central Freeway closed created its own backlash by drivers affected by the longer, slower detour routes, as well as those who used or lived on routes that had been less congested prior to the Central Freeway closure (Robbins, et al). While acceptance of traffic conditions during reconstruction was generally high, a much lower level of tolerance was shown for permanent closure of the Central Freeway. Six months after requesting that the Central Freeway not be reopened, the Mayor requested that Caltrans continue with plans to reopen the facility. Support for this decision was confirmed by subsequent passage of citizen Proposition H (1997), which called for rebuilding the Central Freeway (Robbins, et al).

Only a year later, another citizen sponsored measure – Proposition E (1998) – overturned Proposition H while authorizing construction of a shorter freeway segment touching down at Market Street, and an expanded arterial on Octavia Blvd running north from Market to Fell St replacing the last quarter-mile segment of the Central Freeway (octaviacentral.org). Work is underway on this replacement project.

### Traffic Redistribution and Operations following Closure of the Central Freeway

While many drivers initially avoided areas around the Central Freeway in the days and weeks immediately following its closure, traffic eventually returned – shifting to other facilities - and stabilized to near pre-closure levels. Analysis of publicized detour routes as well as other nearby streets accounted for 94% of trips that had previously used the Central Freeway. Additional study found only a small mode shift to transit (2.2%) or reduction in trip making (2.8%). No shift to carpool was identified (Robbins, et al). Detailed traffic operations analysis of pre- and post-closure conditions was not found, though anecdotal accounts detail increased traffic congestion on other area facilities. Driver frustration with the increased levels of congestion is a factor cited in the successful passage by San Francisco voters of Measure H to rebuild the Central Freeway (Robbins, et al).

### *Notes on Comparing San Francisco's Embarcadero and Central Freeway with the Alaskan Way Viaduct*

Two key factors differentiate the AWW's traffic operations from those of the Central Freeway and Embarcadero. One is that the AWW is the central segment of a regional highway facility. It connects the neighborhoods and industrial areas in NW Seattle with points south of downtown, including Boeing, Sea-Tac Airport and I-5. The AWW distributes 60,000+ daily trips on ramps downtown, while additionally accommodating 40,000 daily through trips. In contrast, the Embarcadero and Central Freeway both served similar, singular purposes – distributing traffic between the regional freeway system and the local arterial system in downtown San Francisco. In their partially completed states, these freeways functioned as long sets of ramps connecting I-80 with the downtown street grid in several locations near the CBD.

The second key difference is that a dense grid of arterial streets and alternate (or replacement) ramps was available in downtown San Francisco to offset the loss of the Embarcadero and Central Freeway. Analysis of pre- and post-earthquake conditions for the Embarcadero showed generally good LOS (Parsons Brinckerhoff, et al, 1993) on arterials in the CBD and Embarcadero area, indicating capacity was available to accommodate additional traffic. Furthermore, the San Francisco CBD's

street grid is developed to the point where numerous connections and access points to a number of redundant routes are provided. It's not clear that the same would hold true in Seattle, where only five north-south city streets parallel the viaduct. Seattle's hourglass shape concentrates most of the CBD traffic onto these five streets, leaving little capacity to handle significant shifts that would occur if the capacity of the AWV was significantly reduced. Compounding the situation, few routes provide access into and out of the Seattle CBD. In addition to SR-99 and I-5, only 1<sup>st</sup> Ave and 4<sup>th</sup> Ave provide significant access opportunities to the south, while 15<sup>th</sup> Ave W, Westlake Ave, and Eastlake Ave provide limited additional accessibility to the north. As such, the Seattle CBD is heavily dependant on SR-99 and I-5 for access.

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